

## ORIGINAL ARTICLE

## Endovascular treatment of renal stenosis in solitary kidney

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## ABSTRACT

**Background:** Endovascular treatment of hypertensive renal disease in patients with a solitary kidney secondary to renal artery stenosis proved to be effective to prevent organ failure and function, as well as hypertension control. When indicated after judicious evaluation using both biochemical methods and the patient's images and signs, endovascular treatment has effective clinical benefits and is little invasive.

**Objective:** To study renal artery stenosis with hypertension and evaluate the effectiveness of endovascular treatment in the control of hypertension, renal failure secondary to renal artery stenosis, and in the prevention of renal failure in patients with a solitary kidney.

**Methods:** This study was performed at the Reference Center of High Complexity in Endovascular Surgery of Hospital de Clínicas da Universidade de Campinas from April 1997 through June 2005 using a previously developed protocol. Ten patients with renal artery stenosis and solitary kidney submitted to endovascular treatment were included. Improvement in hypertension and renal function was assessed through clinical follow-up and laboratory tests using measurements of blood pressure, serum urea levels, creatinine and clearance. Color-flow Doppler ultrasound was performed 30, 90, 180 days after the surgery and yearly thereafter. Aortography and selective renal arteriography were performed in case of doubt as to images or signs. For this population, 90% had hypertension, 70% were smokers, 40% had hyperlipidemia, 30% had carotid artery occlusive disease, 60% had chronic lower limb arterial occlusion, and 20% had diabetes mellitus.

**Results:** Immediate success was 100%. Mean follow-up time was 40 months. Control of blood pressure occurred in 90% of the cases, and in 10% there was significant reduction in urea and creatinine levels and worsening of hypertension after the procedure.

**Conclusion:** Endovascular treatment of renal artery stenosis is a technique that has clinical benefits in hypertension control, preserving renal function and progression of this disease, but without improvement in renal function.

Keywords: Renovascular hypertension, stenosis, stent.

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## RESUMO

**Contexto:** O tratamento endovascular da doença renal hipertensiva, em doentes com rim único, conseqüente à estenose de artéria renal, mostrou ser efetivo na prevenção da falência do órgão, sua função e controle da hipertensão. Quando indicado após avaliação criteriosa, tanto bioquímica como por imagens e sinais do doente, o tratamento endovascular apresenta benefícios clínicos de forma efetiva e pouco invasiva.

**Objetivo:** Estudar a doença hipertensiva renovascular e avaliar a eficácia do tratamento endovascular no controle da hipertensão arterial sistêmica e da insuficiência renal secundárias à estenose da artéria renal e como medida de prevenção de falência renal em doentes com rim único funcionante.

**Método:** Estudo realizado com protocolo de atendimento previamente elaborado, no Centro de Referência de Alta Complexidade em Cirurgia Endovascular do Hospital de Clínicas da Universidade de Campinas, de abril de 1997 a junho de 2005, em 10 doentes com diagnóstico de estenose da artéria renal em rim único funcionante, submetidos ao tratamento endovascular. Foi avaliada a melhora da hipertensão e função renal através de seguimento clínico e laboratorial com medidas de pressão arterial, dosagens séricas de uréia, creatinina e *clearance*. Exames pelo eco-color-Doppler foram realizados no pós-operatório de 30 dias, 3 meses, 6 meses e anualmente; no caso de haver alguma dúvida na obtenção de imagens ou sinais, foi realizada a aortografia e arteriografia seletiva renal. Nesta casuística, 90% dos doentes apresentavam hipertensão arterial, 70% eram tabagistas, 40%, hiperlipidêmicos, 30% apresentavam doença oclusiva cerebral extracraniana, 60%, obstrução arterial crônica nos membros inferiores, e 20%, diabetes melito.

**Resultados:** O sucesso inicial foi de 100%. O seguimento médio foi de 40 meses. Houve controle da pressão arterial em 90%, diminuição significativa dos níveis de uréia e creatinina após procedimento e piora do quadro de hipertensão em 10%.

**Conclusão:** O tratamento endovascular da estenose da artéria renal é uma técnica que apresenta benefícios clínicos no controle da hipertensão arterial, preserva a função renal e desacelera a progressão da insuficiência renal crônica de origem renovascular, porém sem melhora desta.

**Palavras-chave:** Hipertensão renovascular, estenose, stents.

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## Introduction

Renal ischemic disease (RID), or atheromatous renovascular hypertension, affects around 14% of patients aged 50 years or older submitted to hemodialysis. It has unsatisfactory clinical course when there is no specific treatment of renal artery stenosis.<sup>1</sup> Expected 2-year survival for patients with two kidneys and unilateral atheromatous disease is 97%, 82% for bilateral disease and 45% in cases of solitary kidney disease.<sup>2</sup>

Indication for renal revascularization due to atherosclerotic disease in solitary kidney has the following parameters: parenchymal perfusion asymmetry, difficult-to-control hypertension, progressive loss of renal function and renal stenosis higher than 60%. Thus, it is essential to perform a treatment for renal artery stenosis, given that evolution to occlusion is certain and renal failure may occur, which means hemodialysis dependence and/or death.<sup>1,3-5</sup> Clinical treatment is insufficient

to achieve improvement in renal perfusion when compared with percutaneous renal angioplasty,<sup>6,7</sup> and is often comprised of an association of drugs that are unable to maintain proper pressure levels. Therefore, angioplasty/renal stenting in nonostial or ostial lesion repair is important in the treatment described in recent studies, especially in solitary kidneys.<sup>8-12</sup>

Percutaneous renal angioplasty was described by Gruntzig in 1978<sup>13</sup> and progressed with improvement in renal assessment methods, technological innovation of materials, contrasts and techniques. It is accepted as a minimally invasive procedure, with low complication risks and good outcomes. It is a safe choice considering the current and continuous technological innovation of materials, technical enhancement and low-osmolality contrasts. Obtained results are blood pressure control and preservation of renal function.

## Method

A retrospective study was conducted at the Reference Center of High Complexity in Endovascular Surgery (CRACCE) of Hospital de Clínicas da Universidade Estadual de Campinas (UNICAMP), in 11 patients with solitary kidney due to atherosclerotic disease, submitted to endovascular treatment of renal artery stenosis from April 1997 to June 2005 and referred by a service care protocol. The sample was comprised of 10 patients. One died in the first 24 hours due to acute myocardial infarction and was excluded from the sample because there was no follow-up and assessment as proposed. This care protocol was submitted to appraisal by the Research Ethics Committee so that the service could be accredited by the Brazilian Health Department and Health Department of the State of São Paulo.

The patients were referred to the Endovascular Surgery Outpatient Clinic by the nephrology service or by image findings, considering that one patient had diagnostic suspicion performed during an ultrasound assessment of his abdomen, which showed a contracted kidney. In 70% of cases, renal artery lesions were ostial, and in 30% nonostial, although all had an atherosclerotic aspect in arteriographic images. Clinical assessment was performed and risk factors and comorbidities associated with RID were identified: smoking, hypercholesterolemia, diabetes mellitus, hypertension (including information about dose and number of drugs used), renal failure, peripheral occlusive artery disease (POAD) of the lower limbs, extracranial cerebral vascular disease, and coronary disease (Table 1). Next, laboratory exams were performed: blood count, urine I, urea and serum creatinine, and creatinine *clearance*; and imaging exams, such as simple abdominal ultrasound to assess renal morphology and dimension, color-flow Doppler ultrasound of the renal artery to assess stenosis degree and systolic and diastolic velocity peaks, calculating the intrarenal resistance level, and renal scintigraphy using the dimercaptosuccinic acid (DMSA), which assesses perfusion and excretion. These exams configure the patient's and kidney's anatomical and functional profile. All patients were submitted to an angiographic study prior to the procedure.

**Table 1 - Clinical characteristics of patients**

	Female gender	Male gender	Percentage
No. of patients	3	7	100%
Mean age	59 years old	38.1 years old	
Diabetes mellitus	1	1	20%
Hypertension	3	6	90%
Smoking	1	6	70%
Dyslipidemia	1	3	40%
POAD	1	5	60%
COD	-	3	30%

COD = carotid obstructive disease; POAD = peripheral occlusive artery disease.

The treatment was indicated in cases of critical stenosis of the renal artery, progressive deficit of renal function and difficult-to-control hypertension, associated with presence of a solitary kidney. Imminent renal failure was considered when the serum creatinine level was around 1.5 mg/dL or mean glomerular filtration equal or lower than 50 mL/min.<sup>14</sup>

The endovascular surgical procedure is started by an arteriography, since it helps an accurate location of the affected artery *sic* where the stent should be implanted. In severe lesions with stenosis, above 90%, or in cases of difficult progression for the guide wire, angioplasty was performed prior to stent implantation. All patients were given intravenous heparin (5,000 IU) at the beginning of the procedure. Control arteriography was performed by the end of the surgical procedure, and the patient was referred to the ward with controlled hydration and blood pressure and monitored renal function, and prescription of acetylsalicylic acid 200 mg and clopidogrel 75 mg on a daily basis.

Stenoses were defined as critical when larger than 60% of the arterial lumen, as residual when equal to 30%, and as recurrent stenosis when equivalent to approximately 50%. In this group, for a 40-month period, there were no recurrent stenoses, but two patients who had already been submitted to renal artery angioplasty without stent placement in another service were admitted.

During the follow-up laboratory exams of urea, serum creatinine and arterial color-flow Doppler ultrasound were performed in the first, third and sixth months, and yearly thereafter.

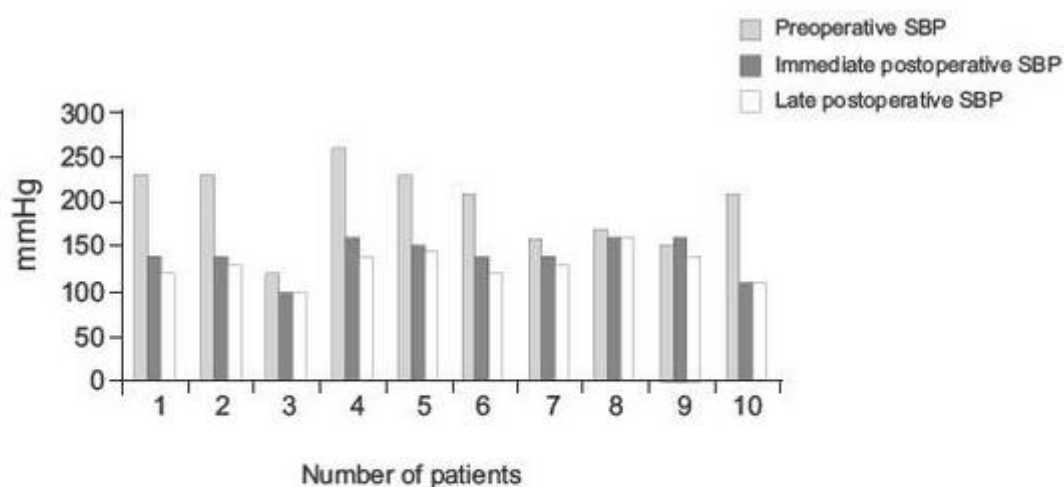
Criteria for clinical improvement were established by a 20% reduction in serum creatinine concentration and reduction in amount of dose or number of drugs used for the treatment of hypertension, with the aim of maintaining diastolic pressure below 90 mmHg. Cure was considered as presence of these pressure levels with no need of taking the medication, and clinical worsening was defined as a 20% increase in creatinine concentration or need of increasing drug dose.

## Results

The endovascular treatment was performed, showing immediate success (stenosis correction) in 100% of cases, although two cases had residual stenoses. A hematoma at the puncture site was observed as complication, but it did not require intervention. Follow-up was performed in 10 patients, who comprise this sample. When the macroscopic morphological result of the vessel was analyzed intraoperatively, it was observed that two patients had residual stenosis, whose new dilatation using an angioplasty balloon was not efficacious, although during the follow-up there was no functional

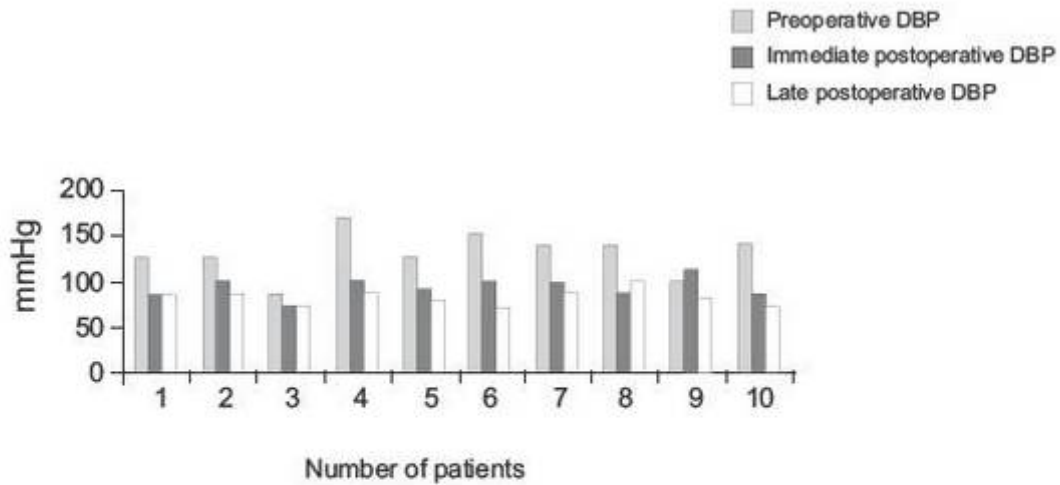
repercussion of the organ or worsening in stenosis degree. In the short- and long-term follow-up of patients, there was no recurrent stenosis with functional repercussions.

Mean hospitalization time was 3 days, and mean follow-up time was 40 months. Systolic and diastolic pressures during the follow-up were reduced to clinical levels within the normal range, with improvement in 90% of cases (9/10) and worsening in 10% (1/10) (Figures 1 and 2). One patient showed worsening of blood, systolic and diastolic pressure in the immediate postoperative period, but in the late postoperative period these were reduced to levels within the normal range. Another patients had high systolic and low diastolic pressure after the endovascular procedure in the immediate postoperative period, but his pressure levels increased and were controlled using a lower dose of medication (lower dose and number of times) in the late postoperative period. A new imaging study (arteriography) showed there was no stenosis, which leads to the assumption that this patient's kidney already has intraparenchymal disease.



SBP = systolic blood pressure.

**Figure 1 - Systolic blood pressure in the preoperative, immediate postoperative, and late postoperative period**



DBP = diastolic blood pressure.

Figure 2 - Diastolic blood pressure in the preoperative, immediate postoperative, and late postoperative period

Blood biochemical tests showed that preprocedure urea levels ranged between 36-156, mean 86.6, which was reduced to 57.6 after the endovascular treatment ([Figure 3](#)); creatinine dosages in the preoperative, immediate and late postoperative period had a small reduction ([Figure 4](#)).

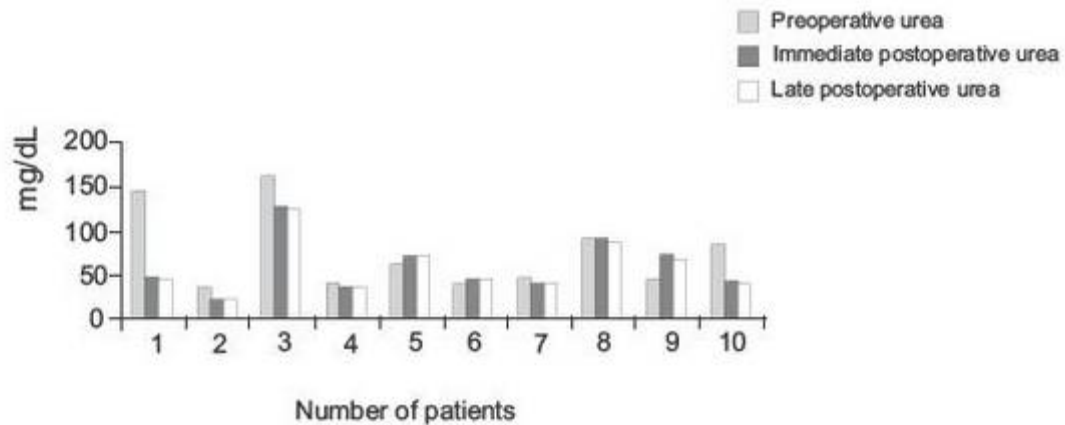


Figure 3 - Urea dosage in the preoperative, immediate postoperative, and late postoperative period

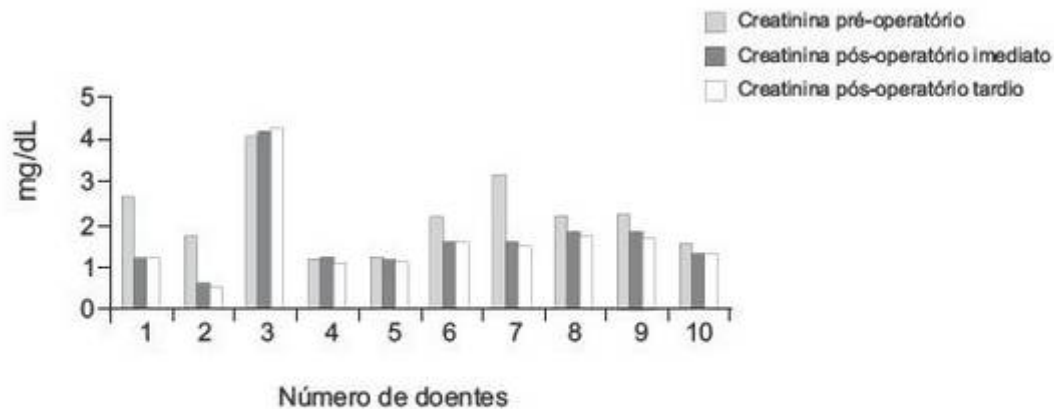


Figure 4 - Creatinine dosage in the preoperative, immediate postoperative, and late postoperative period

Color-flow Doppler ultrasound was performed in the postoperative period showed patent arteries without recurrent stenosis in all patients. The patent status of the artery in the patient who had worsening of diastolic blood pressure was assessed by Doppler ultrasound and also by arteriography, which did not show flow or anatomical impairment.

## Discussion

Obstructive renal disease in patients with solitary kidney has been a reason of concern due to its ability of quickly deteriorating the patient's quality of life. Considering that most organ donations are performed between living donors, if some of these donors have an obstructive lesion of the renal artery throughout their lives they will certainly lose renal or kidney function, with consequent need of hemodialysis.<sup>1,3</sup> Improvement in functional diagnostic and imaging methods and increase in mean age of the population will make this disease another public health concern, since the survival of these patients is 45% in 2 years.<sup>2</sup>

This study aimed at discussing renal hypertensive disease (renovascular hypertension) and assessing the efficacy of endovascular treatment. This treatment was applied to patients with difficult-to-control hypertension, especially in those with high diastolic blood pressure, and in patients with progressive loss of renal function, detected by laboratory tests, and that had a solitary kidney. Discussion of procedure success should be performed considering two aspects: stenosis correction and preservation of renal function. Two patients had residual stenoses, lower than 30% of the arterial lumen, but there was no repercussion in flow and renal function during the whole follow-up period. Use of noninvasive imaging examinations, measuring organ size and presence or not of retraction areas and fibrosis, and measurements of velocity in the renal artery using color-flow Doppler ultrasound were performed in preoperative assessment and help diagnosis and treatment prognosis. Color-flow Doppler ultrasound was performed in seven patients in the preoperative period and in all patients in the postoperative period. There was a high resistance level (preoperative), which means that arterial lesion is the cause of hypertension, and the patient did not develop resistance to the parenchyma, which was intact. Obtaining the resistance level of the renal parenchyma using color-flow Doppler ultrasound shows that high level or low final diastolic velocity mean failure or insignificant improvement in hypertension. These data are in accordance with the pertinent literature.<sup>15</sup> It is important to stress that in the artery follow-up after stent placement there is flow alteration, which was interpreted as normal, and not as stenosis. Radioisotopic assay was also performed. It is extremely important in the assessment of organ perfusion and function, but the test using the diethylene triamine pentaacetic acid (DTPA) is invalid, since it is applicable in case the



patient has two kidneys and only one is impaired; Thus, it is a paired analysis exam. The test with DMSA was used because it is an examination that assesses renal perfusion and excretion, the renal flowchart. Renal arteriography is still considered a gold standard examination, since it provides anatomical data of the obstructive disease and renal morphology, extension and site, vessel diameter and its angle related to the aorta.

The main goal of endovascular surgery is the treatment of renovascular hypertension and/or prevention of renal function loss through angioplasty and stent placement, given that clinical treatment is inefficient when the results are compared with the endovascular technique.<sup>6,7,12</sup> It is known that part of the impaired and functionless parenchyma will not be reverted, but after the treatment the organ will present stagnation of functional impairment and is, therefore, a form of preventing functional deterioration, being particularly important in solitary kidneys,<sup>10,16,17</sup> by mechanisms that have not been well defined.<sup>18</sup> Untreated patients with renovascular hypertension will die within 2 years, although death is not attributed to alteration in renal function, but to coronary disease.<sup>19</sup> Although some authors state that stenosis repair improves hypertension and renal function,<sup>11</sup> preventing these patients from being submitted to a future hemodialysis,<sup>20</sup> it is considered that the function is directly associated with serum creatinine serum and is, therefore, one of the predictive factors of improvement in function after stenosis repair,<sup>16</sup> a nonsignificant fact that was detected in this study. Based on the results obtained in this series, we can claim that renal stenosis repair improves arterial hypertension and reduces renal overload, with consequent improvement in the patient's quality of life, although the sample is small to generalize the results. There was no alteration in renal function or in the anatomical aspect of the renal vessel in the follow-up at 24 and 40 months; thus, the 24-month follow-up is considered as sufficient, which is in accordance with other authors.<sup>10,11</sup>

Technical success is considered when the patient shows improvement in hypertension. Residual stenosis can reach up to 30% of the arterial lumen, considering that patients who receive stents have better functional results than those that are only submitted to artery angioplasty,<sup>17</sup> according to the patient's long-term follow-up. In the 1980's repair of renal artery stenosis was performed using open surgery, with major risks, inherent to a large-sized operation, and patients were submitted to it under worse clinical conditions, with hypertensive disease at a later stage and more impairment of the renal parenchyma, opposed to what currently occurs in endovascular surgery.

## Conclusion

The endovascular treatment for renal artery stenosis in patients with solitary kidney is a technique that has immediate clinical benefits to correct hypertension and preserve renal function, preventing the patient from being submitted to hemodialysis and having renal loss, but the mechanisms for its improvement are still contradictory and little explained.

High resistance level of the renal artery and/or low diastolic velocity, which can be obtained by color-flow Doppler ultrasound, are predictive factors of endovascular surgery success. In the long term (40 months) it can be stated that renal preservation not only improves hypertension and the patient's quality of life, but also prevents hemodialysis, but improvement in function still remains contradictory, since reduction in electrolytes (urea and creatinine) was interpreted as reduction in renal overload.

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